Research Note 86-90



# DATA COLLECTION VIA A QUASI-EXPERIMENTAL SIMULATION TECHNOLOGY: III. Factor Structure and Validity

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The number of measures that are collected from participants in the quasi-experimental simulation technology have continued to increase as the technology has continued to be developed. With as many as 60 separate measures now available, it has become important to determine where commonalities among the measures might exist. The present report explores those commonalities via a factor analysis of scores obtained by more than 100 lower level managers who participated in the simulations. (OVER)

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20. Abstract (continued)

In an evaluation of assessment validity, the present report correlates performance scores and factor scores with sociographic indicators of success (age relevant income and job level, etc.) and, finally, employs multiple stepwise regression procedures to select both the theoretical concepts and the simulation based measures that are optimal predictors of managerial achievement. To date, these predictors include: adequate attention to problems/emergencies; time length of planning; delay between information receipt and response; simplistic actions; breadth of approach to complex task demands; applications of basic strategy; quality of strategy; and the capacity to shift from a strategic to a problem oriented approach as needed, together with the capacity to return to strategic thinking when emergencies are resolved or problems are diminished.

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DATA COLLECTION VIA A QUASI-EXPERIMENTAL
SIMULATION TECHNOLOGY:
III. FACTOR STRUCTURE AND VALIDITY

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In previous reports to the U.S. Army Research Institute we have discussed simulation measurement technology and measurement reliability. The present report extends the information presented earlier. Since our quasi-experimental simulations were specifically developed as assessment and training tools, measurement validity (for assessment purposes) and training effectiveness must be evaluated. In this paper, we will focus upon assessment validity. A subsequent report will be concerned with training effectiveness.

As part of the continuing development of the quasi-experimental simulation technology, the number of measures that are obtained from participants have continued to increase. With as many as sixty separate measures now available, it has become important to determine where commonalities among those measures might exist. The present report will explore those commonalities via a factor analysis (varimax rotation) of scores obtained by more than 100 individuals who participated in either the Shamba or the Disaster simulation (or both). In addition, factor analysis allows the calculation of factor scores which may potentially be more appropriate assessment indicators of performance quality.

In an evaluation of assessment validity, the present report correlates performance scores and factor scores with sociographic indicators of success (age relevant income and job level, etc.) and, finally, employs multiple stepwise regression procedures to select both the theoretical concepts and the simulation based

measures that are optimal predictors of managerial achievement.

LOCUS OF MEASUREMENT

We are concerned with the measurement of managerial performance. Are simulations, especially quasi-experimental techniques, appropriate measurement tools? Before considering the specific characteristics (and accomplishments) of our simulation based measurement, the uninitiated reader may wish to consider whether our techniques represent the appropriate locus and level of managerial assessment. Certainly one may ask whether it would not be more reasonable to measure performance at the organizational level (e.g., group productivity, organizational output variables, cost and profit, group or team performance, turnover and/or absenteeism). Certainly enough information on turnover and absenteeism has been collected to develop comparative standards. Alternatively, we might have chosen to measure standard variables that are concerned with the manager as an individual, e.g., motivation, individual goals, job satisfaction, role stress, and contributions to leadership. On first thought, the choice seems a difficult one. However, is there some way to measure both organizational and individual functioning at the same time?

Beyond questions about the "location" of appropriate measurement, one might be concerned with the "kind" of performance assessment (and training). For example, should we apply judgmental (i.e., subjective) or non-judgmental (i.e. objective) measures (cf. Landy and Farr, 1983)? Measurement of

output, of absenteeism, profit, attainment of agreed upon goals, etc., would reflect objective non-judgmental measurement of performance. Ratings by supervisors, peers or even ratings of a manager by those supervised would represent subjective "judgmental" approaches. Ratings can be very useful: for example, peer ratings during early training can sometimes predict long term success better than other predictor variables. However, problems of distortion may emerge, especially at later points in a person's career. Political considerations, social conflicts, competitiveness, and many other aspects of task, organizational and interpersonal components of the work environment can affect rating outcomes. Leniency, excessive severity, tendencies toward a common rating point for all or many ratees, halo effects, proximity effects and more have been observed. Different effects of the source of ratings are also evident (Cascio, 1982). These differences are not only due to status variables, but also an outcome of insufficient knowledge or inappropriate orientation. For example, ratings by peers may provide a valuable overall performance assessment but tend to be insensitive to differential task/job requirements (Holzbach, 1978).

A developing body of literature attests to the utility of self-appraisal techniques in which an individual judges his or her own job performance. On the positive side, the opportunity to participate in performance appraisal, especially if combined with goal setting, tends to improve an individual's motivation.

On the negative side, however, comparisons with appraisals by supervisors, peers, and subordinates suggest that self-appraisals tend to show more leniency, less variability, more bias, and less agreement with the judgment of others. According to Cascio, however, self ratings also tend to show less central tendency. Cascio has concluded that self-appraisals are more appropriate for counseling and development than for personnel decisions.

Subjective e.g., rating measurement of performance is, in other words, flawed. It may be useful in some cases and for some purposes. Some form of objective measurement should be, where feasible, preferred. But objective performance assessment for personnel that must deal with complex and uncertain tasks suffers from criterion problems. Such criteria as turnover or profit may be affected by unrelated variables or, if not, are at least secondary reflections of actual competence and potential. We must get closer to the assessment of actual competence at the individual level, and to its impact upon a variety of organizational requirements.

<u>Assessing and Training Managerial "Excellence"</u>

Despite the multiple approaches to assessment of performance in complex tasks, success has been slow in coming. It has been especially slow where assessment of managers (executives) is the focus of interest. The many issues involved in the measurement of executive performance have often been debated and reviewed. Without question, the <u>interest</u> in assessing and training

executive competence, for example executive task performance, has been considerable. Nonetheless, only six years ago, Goldstein (1980) described research publications on these management functions as "low in utility" and "dominated by anecdotal presentations." Goldstein continues:*

> "Typically, articles of this type either present a program to train managers to perform a particular act such as responding to discipline problems (e.g., Gill & Taylor 1976) or they discuss a particular issue such as the identification of tomorrow's managers (e.g., Muse 1972). In terms of empirical research, the exception to the lack of activity is found in research on rater training. In general, however, the sad state of this field is consistent with the lack of knowledge and theory development on such topics as leadership and adult learning. McCall (1976) reviewed this literature and concluded that leadership training repeats the mistakes of leadership research. It tends to focus on leadership style and does not take into account the nature of managerial work which often consists of a variety of fragmented activities. Further, it only includes situations limited to the immediate work group. Stogdill (1974) similarly noted that leadership training has not examined the consequences of training to determine the effects on group performance."

Considering the lack of adequate success in measuring executive, especially senior executive performance, what approach should be optimal? Ratings, especially at this level, are not sufficiently effective. Objective measures fail to point out differences. As shown, senior executives all over the world do not differ greatly in experience, training, intellectual competence, and more. On first view, then, we might conclude that assessment of individual competence, for example assessment

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*Note that the term "leadership" in this quote is used in a more general sense, i.e., similar to executive quality. In other words, it is not restricted to the more interpersonal "leading people" orientation.

of information orientation or decision making performance, at least at senior levels, might be less than profitable. What, then, can we do to distinguish between one senior executive who will function in a mediocre fashion and one who would be eminently successful?

We might, simply, attempt to measure external performance criteria that were evident in that person's last job: "What has happened to an organization during the tenure of that particular executive?" "How did a military post perform while a particular officer was in charge?" - How well would such an approach work? Is the performance of an organization or of an organizational unit a true reflection of executive competence? At times it is not. One shortcoming of basing assessment upon such external criteria has been suggested by Guion (1965). The externally defined success of an executive lies largely in meeting major organization goals through the coordinated efforts of the organization. In part, at least, these efforts depend on the kind of influence the executive has upon those whose work his or her own behavior touches. The executive's own behavior contributes to the achievement of organizational goals only by its influence on the perceptions, attitudes, and motives of other people in the organization and on their subsequent behavior. In addition, achieved successes or experienced failures depend on much more than internal organizational phenomena. Economic conditions, actions by opponents/competitors, availability of funds or resources all affect organizational outcomes. In many

cases, these outcomes might be modified but not necessarily reversed by executive actions.

If we would, nonetheless, decide to evaluate executives on the basis of externally observable outcomes, we should be "systematic" in our approach. Hopefully, our methods could be parsimonious. Hopefully, we might be able to focus on only one or very few criteria. How many outcomes are there? Factor analytic techniques to ascertain "external" measurement requirements have been employed to answer that question. According to Campbell, Dunnette, Lawler, and Weick (1970), factorial studies of organizational optimization have identified ten independent performance dimensions. These are (1) business volume, (2) production costs, (3) index of new agent productivity, (4) index of relative usefulness of agents, (5) business mix, (6) manpower growth, (7) managers' commissions, (8) maintenance costs, (9) agent productivity, and (10) market penetration. These dimensions might be used as criteria against which executive performance appraisal decisions can be made.

According to Campbell, et. al., global measures of managerial effectiveness can also be used as criteria for assessing managers. One widely used procedure consists simply of rankings by former superiors on total managerial effectiveness. Others include salary and organizational level indices, corrected statistically for age or length of time in an organization. These measures constitute broad conceptions of success, but have the added advantage of reflecting pooled estimates of many

superiors' judgments over an individual manager's total career. Such indices, thus, constitute a summation of an executive's ability to optimize organizational systems and to perform crucial managerial job activities. Of course, observation of such broad measures may suffer from an inability to identify as fully as possible all behaviors judged to be relevant to the conceptual criterion. A variety of issues serve to contaminate this approach. Included among these are observational errors such as response sets, chance response tendencies and differential observer characteristics or perspectives, e.g., those which occur among peers, subordinates and superiors.

Clearly, the external criterion approach has not provided us with a parsimonious method of executive assessment. Should executives only be selected if they are competent in all these areas of endeavor? Should they be trained in all of them? Do different executive tasks or different executive positions require different combinations of expertise? We don't have final answers to these questions. But, possibly the most serious flaws of external "results" measurement are the confounding effects of specific executive task environments. It is well known that corporate vice presidents who are placed in charge of a division during a recession are often fired, while those who take control of that division at the time of an economic upswing may find themselves promoted or may be hired as President of another company. In other words, we need more than mere perceptions or measurements of outcome. At least in addition, we need to know

what decisions were made by an individual executive, why they were made and _how_ they were made. We need to know more about the specific _style_ of the manager. We need to know how a manager interfaces that style with _changing_ task demands.

The interest in individual difference characteristics that may motivate and control executive behavior has resulted in attempts to engage in systematic _multiple_ measurement of personality and stylistic characteristics of managers. Entire units within organizations as well as independent corporations whose purpose it is to serve other organizations have grown up around the multiple measurement notion. Their sole purpose may be the prediction and training of executive information handling and performance. Many of these efforts are now handled in "Assessment Centers."

According to Finkle (1976), the original model for assessment centers was generated by American Telephone and Telegraph Company in 1956. Subsequently, many large organizations, including most Fortune 500 corporations, have employed this technique. The assessment center approach is generally distinguished from other managerial assessment techniques by the use of a fixed size group of assessees. Typically, the choice size for this group is approximately 12 individuals. Another unique characteristic is the use of multiple assessment methods. Typically, these include such measures as: objective tests, projective tests, interviews, situational exercises and peer ratings, among others. Typical

objective tests may be such techniques as: the Miller Analogies Test, the Watson-Glaser Critical Thinking Test, the Guilford Martin Personality Inventory, the Edwards Personal Preference Scale, and the Allport-Vernon-Lindsey Scale of Values, among others. Projective instruments often include the Thematic Apperception Test as a standard technique.

Assessment centers, of course, both benefit and suffer from the specific techniques that they utilize. Their approach of measuring individual competence, its emergence and application in task group settings is excellent in conceptualization. Unfortunately, the techniques used by different assessment centers differ widely, making comparative evaluations on an overall basis difficult. Key validity studies have demonstrated the usefulness of certain assessment center techniques for specific organizations. However, less is known about the general applicability of assessment center results to a variety of corporate and military task requirements. As Finkle (1976) has stated:

> "The most critical factor in further applications (of assessment centers) would clearly seem to be the need of continued close, qualified, professional guidance and ad-hoc verification and control.... Given such professional attention, the theme concepts of the assessment center package can and will emerge as helpful and (contain) much needed input to critical organizational manpower decisions."

What Should be Measured?

The value of the assessment center approach is its focus on the existence and application of individual competence. But, for example, will the Miller Analogies Test, will participation in

group task performance reveal the <u>important</u> characteristics of a manager, i.e., the characteristics that lead to organizational success? Will obtained scores predict excellence across a wide variety of tasks? Will they be sensitive to the capacity for change when task environments change? The potential exists. However, generally, that important goal is not attained. That goal has been especially elusive in the assessment and training of senior executives and of those who would, some day, advance to senior levels.

The problem, again, is found in the absence of appropriate and meaningful criteria. To determine what makes excellent senior executives differ from mediocre senior executives, we must first identify the underlying causes of those differences. We must look beyond ratings, intellectual capacity, interpersonal skill and many of the other values that are obtained via the usual assessment methods. We must go beyond descriptive terms such as "intuition" (Isenberg, 1984) that claim to "explain" these differences. We should clarify and achieve a basic understanding of certain characteristics that are ascribed to excellent senior executives such as "strategic opportunism" (Isenberg, 1986). Indeed, eminently successful and not so successful executives differ in their application of strategic opportunism. But, what is it? What kind of capacity, what kind of thinking, what kind of information processing underlies that form of "excellence," especially at senior levels?

The majority of "individual" assessment techniques and their associated training methodologies tend to either focus on a very "basic" level of analysis or employ rather complex procedures such as "free" simulations (cf. the definitions and distinctions provided by Fromkin and Streufert, 1976, 1983; Streufert and Swezey, 1986). The more basic assessment methods, including objective and projective tests (as well as most interviews), tend to provide ample information about motivation, technical skill level, experience, native intelligence and about trained competence to deal with specific events. To the degree to which obtained information can be considered an accurate reflection of an executive's capacity, that information is certainly useful, especially at junior levels. But it is not enough. At higher executive levels, the problem is compounded. As already stated above, senior level executives both in private industry and in the military do not differ greatly in such characteristics as motivation, intelligence and experience. Something else affects their level of competence.

In contrast, then, measuring and training performance in highly complex task settings, e.g., via free simulations, appears to be more appropriate. But is it? Not always. Certainly "real" performance in a potentially quite realistic miniature task of sufficient complexity is observed, assessed and potentially trained. However, the typically employed free simulation techniques still suffer from criteria problems. Since each executive or team of executives make(s) decisions that

affect their environment "down the line," each is, in fact, exposed to a different developing task environment. The performance of different individuals and different groups cannot be meaningfully compared. Systematic comparative analysis is not possible. Task demands, modified by the actions of participating executives themselves, may be more or less demanding and may involve diverse levels of uncertainty and complexity. In other words, the obtained data would only provide limited insights into the potential performance capacity of evaluated executives. That would especially be the case where assessment is to be valid or training is to be applicable to a wide variety of fluid task requirements and situational conditions.

Any more useful, yet adequately complex technique to assess executive competence and to predict executive performance would have to operate at a "middle ground" where executives would function in a controlled (more or less constant across individuals or groups) task environment that would, nonetheless, closely approach the multifaceted, uncertain and fluid tasks that senior executives may face. The technique would have to permit measurement of "what" executives do in response to events and task demands. It would also have to measure "how" executives approach their jobs. It would have to assess how executives think, how they obtain and deal with information and how they go about making decisions, either as individuals or as participants in task groups. The technique would have to measure how strategies are developed, applied and tied to goals. It would

have to consider goal structure. It would have to measure flexibility of thought, of information orientation, of decision making, of strategy development/application, and of goal orientation. Most of all, the method must be able to measure these varying aspects of executive functioning reliably. It must achieve a level of validity that permits meaningful predictive assessment and training. Finally, the technique must extend beyond the contributions to executive performance that are due to "experience", "intelligence", "motivation", and standard forms of "training" (including educational level).

Streufert and associates (Streufert, in press; Streufert and Swezey, 1986) have discussed a quasi-experimental simulation technique that fulfills these requirements. This assessment and training technique was based on the early development of experimental simulation techniques by Streufert, Clardy, Driver, Karlins, Schroder and Suedfeld, 1965 and by Streufert, Kliger, Castore and Driver, 1967. Experimental simulations have been utilized to obtain a large quantity of data that are concerned with a number of environmental and task effects (as well as individual difference effects) upon a variety of performance/decision making variables (cf. e.g., Streufert, 1970; Streufert and Streufert, 1978). The multiple information gained in these research projects was useful in efforts to tailo. a quasi-experimental simulation methodology toward more optimal executive assessment and training. In its most recent version, the quasi-experimental simulation technique provides for the (automated)

measurement of some sixty aspects of managerial decision making performance (cf. e.g., Streufert, Pogash and Piasecki, 1986) which load on ten orthogonal performance factors (see below).

Two simulation scenarios are presently available. Inter-simulation measurement reliability for structural measures (how executives deal with their tasks) varies from +.65 to +.95 (Streufert, Pogash, Piasecki, Hunter and Repman, 1986). We will initially consider the factor structure of our simulation based measurement.

## FACTOR STRUCTURE

In previous reports, we have provided extensive information about our simulation based measurement techniques (formulas) and about the reliability of those measures (Streufert, Pogash and Piasecki, 1986; Streufert, Pogash, Piasecki, Hunter and Repman, 1986). Since the completion of these earlier reports, four additional measures of decision making performance have been added to the simulation software. To begin with, let us consider the characteristics of those four measures.

### Additional Measurement

Among the measures discussed in earlier reports, several were designed to assess strategic capacity. The most basic of those measures, "Number of Integrations," considered the frequency of single strategic interconnections between any two sequential actions. If an initial action was taken to make a subsequent action possible, and if that later action was actually carried out, a single "simple" strategic intent was scored. Obviously, the simulation participant(s) had engaged in one step of forward planning. In contrast, if simulation participant(s) made use of a previous action in a later action without any earlier intent to engage in that subsequent action, credit for opportunistic (backward) thinking was given. Measure 4 of our simulation technology assesses strategic "Forward Integrations." Measure 7 assesses opportunistic "Backward Integrations."

The single step strategic measurement reflected in Measure 4 (Forward Integration) has provided the foundation of more complex

measurement techniques which were designed to assess more advanced strategic capacity. Of course, without strategic forward integrations which span only a single step between two subsequent actions, more complex strategies (which, for example, might consist of lengthy chains of strategies) would not be possible. As a consequence, measurement techniques to assess more complex strategic thinking and performance utilize formulas which include the assessment of simple strategic actions.

Let us consider an example (cf. Streufert, Pogash and Piasecki, 1986). Our simulation based measurement of the Time Length of Forward Planning (Measure 6: Time Weight) weighs each single strategic step between two actions by the length of elapsed time between the two actions. Similarly, Measure 9, Quality of Integrated Strategies (QIS) considers the time elapsed between any two actions in a strategic sequence multiplied by the number of preceding and subsequent strategic steps that are directly related to the first and the second action in that strategic sequence. Measure 10, Weighed QIS, expands this process by including all related past and future strategic sequences, no matter how far they may be removed in time or in stepwise sequences. Finally, Measure 5, Multiplexity, focuses on the number of forward strategic steps that follow any present strategic sequence.

As stated earlier, all these measures of a more complex strategic capacity include the value (frequency count) of the Number of Forward Integrations measure (Measure 4) as part of

their formula. In other words, each of the measures of more complex strategic performance is intentionally confounded with the Number of Integrations measure. Further, each higher level measure is intentionally confounded with the next lower antecedent measure. For example, QIS contains the formula for Time Weight, WQIS contains the formula for QIS and so forth. For most purposes such confounding is useful. Obviously, any higher level of strategy cannot be accomplished without the capacity for the next lower level. For example, measuring time length of strategic (integrated) planning is meaningless if no strategic plans were made in the first place.

However, as our strategy measurement was previously designed, the measures told us little about the added competence represented by each higher level strategy measurement procedure. An understanding of added competence can, for example, be highly useful in the development and evaluation of theory, especially theories that are based on observations.* Consider the view of Streufert and Swezey (1986) who have argued that the number of steps of strategic planning capacity are predictive of executive competence. In contrast, Jaques (1976) has suggested that the maximum time length of planning predicts managerial competence. Our previous measures were not able to distinguish between the number of steps and the time involved in utilizing those steps. To determine whether either Jaques or whether Streufert and

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*Observations necessarily confounded higher order strategies with their lower order antecedents.

Swezey are correct, a clear measurement distinction between stepwise and time based planning must be made. In other words, we must consider, for example, the specific component contributions that are inherent in the Time Weight Measure (representing at least part of the views advanced by Jaques) as well as those that are inherent in Streufert and Streufert's (1978) QIS measure (representing at least part of the views of Streufert and Swezey). In the view of the latter authors, extensive time length of planning may be counterproductive for executive performance (cf. also the work of Isenberg, e.g., 1984). Indeed, Jaques' capacity to predict managerial competence on the basis of the time length of planning might be due to the confounding of time length with planning frequency (e.g., the number of steps needed to achieve a long-range goal).

To separate the predictive components of various measures of strategic competence (strategic action in the simulations), i.e., to calculate the additional capacity for strategic performance inherent in each higher order measure, four new formulas were developed. Each of these formulas divides the obtained value of our previous measures of strategic performance (e.g. QIS) by the next lower level of strategic assessment (e.g., Time Weight). (In addition, each of these formulas can be expressed as a proportion of general activity, i.e., the number of decisions made.) The following four measures were added as part of the revised simulation software:

Measure 5Q: Component Contribution by Multiplexity F*

$$\frac{\sum_{1}^{p} W\,(1 + n_f)}{\sum_{1}^{p} W}$$

Measure 6Q: Component Contribution by Integration Time Weight

$$\mathrm{Ln}\,\frac{\sum_{1}^{p} W}{\sum_{1}^{p} i_f}$$

Measure 9Q: Component Contribution by QIS

$$\mathrm{Ln}\,\frac{\sum_{1}^{p} W\,(1 + n_p + n_f)}{\sum_{1}^{p} W}$$

*The formulas might have been mathematically simplified for this report. However, they are provided in a form that clarifies their derivation. For an explanation of terms, the uninitiated reader is referred to Streufert, Pogash and Piasecki (1986).

Measure 10Q: Component Contribution by WQIS

$$\mathrm{Ln}\frac{\sum_{1}^{p} W\,(1 + n_{pp} + n_{ff})}{\sum_{1}^{p} W\,(1 + n_{p} + n_{f})}$$

## Factor Extraction

Factor analysis of performance scores obtained in 111 simulations was based on the intercorrelations of 48 measures. The measures are (1) those discussed in the report by Streufert, Pogash and Piasecki, (1986), (2) the four Q measures discussed above, and (3) 11 quotients describing the proportional incidence (P scores) of performance frequencies. P scores were calculated by dividing a relevant measure score by the number of decisions made (actions taken) during the time period addressed by that particular measure based score. The obtained "P scores" are identified by the basic measure number (see Streufert, Pogash and Piasecki, 1986) to which they apply: that is as Measures 4P, 7P, 8P, 17P, 19P, 20P, 21P, 22P, 27P, 28P and 36P.

Twelve factors accounted for 85.4% of the variance in the data. Lower order factors tended to reach asymptote in their Eigenvalues and were ignored. The variance accounted for by each of the largest 12 factors is presented in Table 1. Factor Interpretation was based on Varimax rotation procedure. Analysis utilized a SPSS-PC + programs. Each factor is discussed below in

TABLE 1

PERCENT OF VARIANCE ACCOUNTED FOR BY TWELVE FACTORS

| Factor | Eigenvalue | Percent of Variance | Cumulative Percent |
|---|---|---|---|
| 1 | 17.88 | 37.3 | 37.3 |
| 2 | 4.02 | 8.4 | 45.6 |
| 3 | 3.33 | 6.9 | 52.6 |
| 4 | 2.92 | 6.1 | 58.7 |
| 5 | 2.43 | 5.1 | 63.7 |
| 6 | 2.25 | 4.7 | 68.4 |
| 7 | 1.78 | 3.7 | 72.1 |
| 8 | 1.64 | 3.4 | 75.5 |
| 9 | 1.45 | 3.0 | 78.6 |
| 10 | 1.20 | 2.5 | 81.1 |
| 11 | 1.09 | 2.3 | 83.3 |
| 12 | 1.00 | 2.1 | 85.4 |

order of the amount of variance accounted for:

Factor 1: Simple Strategy

The largest single factor is defined by highest loadings on variables 4P (Number of Integrations in Proportion to Number of Decisions, loading +.90) and 22P (Integrations within Decision Categories in Proportion to Number of Decisions, loading .89). Other measures loading highly on this factor include 36P, 5Q, 4, 20P, 22, 36 and 19P (all above .8), 21P, 21, 20, 34 and 19 (above .7), 32, 35 and 7P (above .6), 7, 13, 12 and 2 (above .4). General Unintegrated Decision Making loaded negatively (Measure 14, loading = -.49).

While some measures of higher order strategy do load on this factor, including one of the Q measures, the defining measures (as well as the majority of other measures which relate to this factor) reflect simple, more likely single step or short-term strategic actions.

Factor 2: Activity

The second factor is defined by scores for Measures 1 (Number of Decisions Made, loading .95) and 3 (Number of Decision/Action Categories, loading .91). Measure 17, (Number of Decisions in Response) generated a loading of .77, with Measures 20 (Total Forward Integrative Activity), 19 (Total Integrative Activity), 7 (Number of Backward Integrations), 12 (Planned Integrations), 8 (Number of Unintegrated Decisions), and 2 (Number of Respondent Decisions) loading between .4 and .6. The activity focus of this factor is undeniable. All variables that

involve general frequency counts of activity are represented at levels of at least .4.

Factor 3: Low Level Performance

Factor 3 is defined by a loading of .89 on Measure 8P and .79 on Measure 8, reflecting Unintegrated (i.e., non-strategic) Decision Making. Also represented are Measures 2, Respondent Decisions, and 7 Backward (i.e., unplanned opportunistic) Integrations at loads above .6. Measures 13, Planned (but unfinished) Strategic Integrations, and 19, Total Integrative Activity both load above .4. The inclusion of Measure 19 on this factor was generated by the contributions of Measures 7 and 13 to this score. It should be noted that the TFIA Measure 20 did not load meaningfully on Factor 3, despite the fact that the latter measure includes the contribution of planned but incomplete actions (cf. Measure 13). In other words, we are dealing with rather simple but possibly quite "decisive" responses to the simulated task.

Factor 4: Complex Strategy

The defining measure on this factor is Measure 23, Proportion of Category Integrations (loading .80). This measure reflects the level of preponderance of strategic actions that cross widely disparate action areas as compared to strategic actions that address related and similar areas of activity. Persons scoring high on Measure 23 tend to have a broad overview and use their understanding to generate a more encompassing strategic approach to executive actions.

Other measures loading on this factor include (not surprisingly) 21 (.45) and 21P (.53) reflecting strategic integrations across diverse decision categories, Measures 28P (.61) and 28 (.56) reflecting the integrative strategic application of information obtained through previous search as well as two of the Q measures. Measure 9Q, component Contribution by QIS loaded .48. A possible surprise to some readers may be the negative (-.50) loading of Measure 6Q, Component Contribution by Integration Time Weight. The views of Jaques (1976) would likely have associated that measure positively with complex strategic activity. Whether or not Measure 6Q or a factor loading heavily on 6Q would predict executive success will be considered later in this paper.

Clearly Factor 4 describes individuals who possess a broad overview and who interrelate quite diverse task components to generate an encompassing strategy.

Factor 5: Hierarchical, Analytic and Inflexible Strategy

This factor is defined by negative loadings on Measures 24 (-.91) and 25 (-.89). Both of these measures assess the capacity to shift between more decisive and more planned strategic actions as task demands change. The persons defined by the obtained negative loadings on this factor are not able to adapt their style to variations in task demands. They may, on the other hand, possibly be persons who can plan long into the future (Measure 6Q loads at -.36). However, these individuals seem to differ greatly from individuals who develop sequential stepwise

and <u>complex</u> strategies (Measures 9Q, loading .35 and 10Q, loading .59 suggest the absence of Quality of Integrated Strategies at all levels).

Factor 6: Sensitivity to Emergencies

Factor 6 generated the highest loading for Measure 33, Number of Decisions Made in Response to an Emergency, loading .80. Measures 31, Integrated Responses to the Emergency, and 32, Applied Actions Related to the Disaster, loaded between .65 and .70. Measure 35, Total Integrative Activity Related to the Emergency produced a value of .47. A negative loading of -.43 on Measure 29, Disaster Response Speed, indicates that responses to the advent of the emergency were generated quickly and likely decisively.

Factor 7: Information Search Activity

Factor 7 is defined by loadings of .84 on Measure 27P and .83 on Measure 27, reflecting the frequency with which simulation participants engaged in Information Search. The utilization of previous search in strategic activity at a later time is reflected in loadings of .46 on Measure 28P and .44 on Measure 28.

Factor 8: Spread Across Decision Categories

This factor was generated by extremely high loadings (.96 each) on two highly similar measures (15 and 16) and represents only a reflection of that measure. The factor will be ignored because of its identify with a measure, i.e., its limited implications for measure commonality.

Factor 9: Response Speed

Factor 9 is defined by Measures 18, Most Recent Response Speed, loading .91, and Measure 11, Average Response Speed, loading .85. While the first of these measures assesses the time between the receipt of information and the first action responding to that information, the second considers all relevant responses and their average distance in time to the receipt of information. Persons with high scores on this factor would likely delay action; persons with low scores would likely respond rapidly to information receipt.

Factor 10: Emergency Response Speed

Loadings of .76 on Measure 30, Average Disaster Response Speed, and .56 on Measure 29, First Respondent Decision in Response to information communicating an Emergency suggest that we are dealing with the rapidity of handling a serious emerging problem. A loading on this factor for Measure 17P (-.65) is also of interest. It is possible that persons who respond immediately (decisively?) to a disaster make more respondent decisions overall.

Factor 11: Recovery 1

Factor 11 is primarily defined by Measure 26, Recovery 1, loading .84. That measure reflects the degree to which simulation participants were able to re-establish strategic planning after an emergency had been dealt with. Lesser loadings on Measures 28 (.33) and 28P (.25) probably imply that the strategic (integrated) utilization of previously obtained

information may be an important ingredient in recovery from more applied and immediate responses to a temporary emergency.

Factor 12: Recovery 2

With only a single (negative) loading (-.85) on a single measure (#37, Recovery 2), this factor had little value beyond the score obtained for the Measure it describes. Consequently the factor will be ignored.

## VALIDITY

### Indicators of Success: A Correlational Analysis

The scores obtained in 111 completed simulations reflect the performance of a variety of diverse individuals. While all simulation participants had at least some decision making or managerial experience, the level and characteristics of that experience was quite disparate. To obtain indications of validity across such a diverse sample of participants, relatively non-specific indicators of attained success were chosen as potential bases for a validity analysis. Among them are measures of job and income characteristics. In addition, other potentially interesting variables describing respondent characteristics, e.g., satisfaction measures, were added. The following descriptors of simulation respondents were assessed outside of the simulation environment:

1. Job Success
2. Occupational Level
3. Number of Persons Supervised
4. Length in Present Position (negative)
5. Number of Job Changes in the Last 10 Years
6. Job Satisfaction (on a scale from 1-low to 7-high)
7. Job Level Satisfaction (1-7 scale)
8. Satisfaction with Pay (1-7 scale)
9. Personal Income
10. Number of Changes of Organizations in 10 Years
11. Number of Promotions in 10 Years

12. Personal and Spouse Income Combined

13. Educational Level

Some of the 13 measures, obtained from responses to a biographical inventory, were expected to be partial but direct indicators of success. Others (e.g., Educational Level) were expected to be independent contributors to success that might have their own impact on managerial competence. Adjustment of scores for age and job type were based on values (e.g., income levels) obtained from the Bureau of Labor Statistics (U.S. Government).

Correlations between biographic indicators and a number of simulation measures were calculated. Simulation measures were selected for this purpose if they loaded highest or highly on any one of the previously discussed factors or if they were of interest for theoretical reasons. For example, Measure 6Q (see the discussion of added measures below) was included for theoretical reasons because of its importance to the views of Jaques versus Streufert and Swezey. The following measures were intercorrelated with biographical indicators:

1. Measure 4P: Number of Integrations as a Proportion of Decisions (measuring simple strategy).

2. Measure 22P: Integrations within Categories as a Proportion of Decisions (measuring strategy within a specific focus area).

3. Measure 1: Number of Decisions.

4. Measure 3: Number of Decision Categories (a measure of the different kinds of actions taken).

5. Measure 8P: Number of Unintegrated Respondent Decisions as a Proportion of the Number of Decisions (a measure of the extent of rather simplistic functioning).

6. Measure 6Q: Specific Contributions by the Time Length of Planning (a measure reflecting the characteristic which reflects Jaques views of executive success).

7. Measure 23: Proportion of Category Integrations (a measure of the breadth of a strategic approach).

8. Measure 24: Emergency Shift 1 (an assessment of decision maker capacity to shift from an integrated strategic mode of action to a respondent mode whenever task demands require).

9. Measure 25: Emergency Shift 2 (Measure 24 corrected for the actual amount of effort expended on decision making activity which is related to an emergency). Note that both measures 24 and 25 produce <u>low</u> scores where performance is excellent, i.e., <u>negative</u> correlations would be expected if these measures are predictive of success.

10. Measure 33: Number of Disaster Decisions (a measure of activity that is directly related to handling an emergency).

11. Measure 27P: Number of Information Search Decisions as a Proportion of the Number of Decisions.

12. Measure 11: Average Response Speed (a measure of the mean time distance between relevant actions and previously received information.

13. Measure 18: Most Recent Response Speed (the rapidity of response to incoming information.

14. Measure 29: Disaster Response Speed (the rapidity of response to information that is communicating an emergency).

15. Measure 30: Average Disaster Response Speed (a measure of the mean time distance between relevant actions and the receipt of information about an emergency).

16. Measure 26: Recovery 1 (a measure of the capacity to regain a strategic orientation after problems associated with an emergency have been resolved).

17. Measure 5: Multiplexity F: (a measure of stepwise forward strategic planning, without consideration of the time length of planning).

18. Measure 5Q: The specific contributions of the complexity of stepwise forward planning without consideration of its frequency.

19. Measure 9: Quality of Integrated Strategies (a measure of the overall complexity of forward planning in the past, the present, and toward the future as well as the degree of interrelatedness of multiple strategic plans).

20. Measure 9Q: The specific contributions of the <u>complexity</u> of previous and current forward planning obtained via Measure 9 without consideration of the frequency and time length of strategic planning.

21. Measure 10Q: The specific contribution of the complexity of sequential chains of planning as obtained via Measure 9Q <u>beyond</u> any three sequential steps in a strategic sequence.

The intercorrelations between biographical indicators and simulation measures as well as any obtained significance levels for those intercorrelations are obtained in Table 2. A view of the results suggests that the most significant intercorrelations with simulation measures are obtained for Income Level, with additional useful data obtained for Occupational Level and, to some extent, for the Number of Persons Supervised. To present a more easily read listing of results Table 3 was prepared. That table lists the significance levels represented by some of the intercorrelation between simulation measures and the three most important indicators of (biographically obtained) success.

One additional interesting finding that suggests a focus for future research should be noted. Significant positive correlations between such biographic success variables as Personal Income and measures of strategic performance such as Number of Integrations were often associated with significant

TABLE 2

INTERCORRELATIONS OF BIOGRAPHIC AND SIMULATION PERFORMANCE MEASURES
CORRELATION COEFFICIENTS TO 2 DIGITS WITHOUT THE DECIMAL POINT

| PERFORMANCE MEASURES | EARNINGS AGE/JOB CORRECTED | OCCUPATIONAL LEVEL | NUMBER OF PERSONS SUPERVISED | LENGTH IN PRESENT POSITION | NUMBER OF JOB CHANGES 10 YEARS | JOB SATISFACTION 1 - 7 | JOB LEVEL SATISFACTION 1 - 7 | SATISFACTION WITH PAY | PERSONAL INCOME | NUMBER OF CHANGES OF ORGANIZATIONS IN 10 YEARS | NUMBER OF PROMOTIONS IN 10 YEARS | JOINT INCOME WITH SPOUSE | EDUCATIONAL LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4P | -02 | 24** | 02 | -04 | 04 | 04 | 01 | -34** | 17* | -10 | 14+ | 12 | 34** |
| 22P | -06 | 09 | 07 | -03 | 01 | -05 | -09 | -39** | 12 | -14+ | 16* | 04 | 15+ |
| 1 | -09 | 02 | 04 | -25** | 08 | 01 | -04 | -11 | 03 | 02 | 18* | -03 | 14+ |
| 3 | -11 | 05 | 0 | -22* | 06 | 03 | -03 | -12 | 02 | -02 | 22* | -02 | 16* |
| 8P | -09 | -12 | 04 | -06 | 0 | 05 | 12 | 02 | -17* | -09 | 04 | -13+ | -15+ |
| 6Q | -06 | -13 | -10 | 24** | -10 | 04 | 06 | 23** | -13+ | 02 | -21* | -09 | -17* |
| 23 | 01 | 12 | -01 | -11 | 01 | 08 | 02 | -11 | 02 | -01 | -01 | -02 | 20* |
| 24 | 03 | -12 | -11 | 11 | 06 | 02 | -04 | -01 | -02 | 25** | -02 | -05 | -09 |
| 25 | -04 | -12 | -08 | 11 | 09 | 06 | -02 | 01 | -08 | 29** | -04 | -09 | -10 |
| 33 | -14+ | 24** | 0 | 01 | -04 | -18* | -03 | -09 | 03 | -14+ | -03 | -03 | 27** |
| 27P | 0 | -08 | -02 | 05 | -05 | 12 | 13 | 01 | 17* | -09 | 16* | 21* | -11 |
| 11 | -10 | 02 | 20* | -19* | 20* | 0 | -09 | -07 | 22* | 21* | 25** | 06 | 08 |
| 18 | -12 | 03 | 14+ | -11 | 10 | -14 | -06 | 02 | 32** | 14+ | 08 | 18* | 08 |
| 29 | 23** | -05 | 16* | 05 | 10 | -01 | 01 | 06 | 09 | 18* | 04 | 07 | -06 |
| 30 | 15 | 05 | -01 | 20 | -06 | -04 | 01 | 04 | -01 | -04 | -03 | 02 | 05 |
| 26 | -12 | 01 | -05 | -02 | -09 | -13 | -14+ | -10 | -06 | -08 | 04 | -05 | 03 |
| 5 | -08 | 09 | -01 | 01 | -02 | 01 | -06 | -23** | 0 | -05 | 12 | -08 | 15+ |
| 5Q | -08 | 10 | -0 | 01 | -02 | 01 | -06 | -24** | 01 | -05 | 13+ | -08 | 16* |
| 9 | -11 | 14+ | 13+ | -22* | 16* | 02 | -03 | -30** | 15+ | 01 | 20* | 08 | 23** |
| 9Q | 13 | 16* | 17* | -10 | 06 | 06 | -05 | -12 | 20* | 0 | 05 | 11 | 14+ |
| 10Q | -12 | 10 | 09 | -34** | -03 | -04 | -01 | -12 | 08 | -16* | 11 | 06 | 12 |

Negative Intercorrelations were obtained and expected for Measures 6Q, 8P, 24 and 25.

r = 13 < .10+
r = 16 < .05*
r = 23 < .01**

TABLE 3

SIGNIFICANCE LEVELS OBTAINED FOR THE INTERCORRELATIONS OF SIMULATION MEASURES AND BIOGRAPHIC INDICATORS OF SUCCESS

1. CORRELATIONS WITH PERSONAL INCOME

| Simulation Measure | | Significance Level $p <$ |
|---|---|---|
| 4P | Number of Integrations | .05 |
| 8P | Unintegrated Respondent Decisions (negative)* | .05 |
| 6Q | Time Length of Planning (negative)* | .10 |
| 27P | Number of Information Search Decisions | .05 |
| 11 | Average Response Speed | .05 |
| 18 | Most Recent Response Speed | .01 |
| 9 | Quality of Integrated Strategies (QIS) | .10 |
| 9Q | QIS Contributions Independent of Time Length of Planning | .05 |
| 29 | Disaster Response Speed (corrected for age/job level) | .01 |

2. CORRELATIONS WITH OCCUPATIONAL LEVEL

| Simulation Measure | | $p <$ |
|---|---|---|
| 4P | Number of Integrations | .01 |
| 33 | Number of Emergency Decisions | .01 |
| 9Q | QIS Contributions Independent of Time Length of Planning | .05 |

*Negative indicates that a negative correlation was expected and obtained.

3. CORRELATIONS WITH NUMBER OF PERSONS SUPERVISED

| Simulation Measure | | $p <$ |
|---|---|---|
| 11 | Average Response Speed | .05 |
| 18 | Most Recent Response Speed | .10 |
| 29 | Disaster Response Speed | .05 |
| 9 | Quality of Integrated Strategies (QIS) | .10 |
| 9Q | QIS Contributions Independent of Time Length of Planning | .05 |

negative correlations between simulation performance variables and satisfaction (for example Measure 4P, Number of [strategic forward] Integrations and Satisfaction with Pay correlate $r = -.34$, $p < .01$). On the other hand, Measure 4P correlates significantly positive with Job Level, Income and Educational Level. In part, these results may be due to the depressed economic condition of Pennsylvania from which the research participants were primarily drawn. Alternatively, the results might reflect some specific characteristic of persons who do or do not possess the capacity to perform complex tasks in a multi-dimensional fashion (cf. Streufert, in press, Streufert and Swezey, 1986). Only subsequent research efforts will be able to reach conclusions about the underlying basis of this finding.

The obtained data suggest that a number of simulation measures are meaningfully (significantly) related to biographic indicators of success. It should be noted that correlations between simulation performance variables and educational level also reached significance but were not excessive. Some covariation between simulation performance and educational level was expected since the potential knowledge of the kinds of actions that might be combined in a strategy is, in part, a function of intelligence, education and experience. As Streufert (in press) has suggested, education, intelligence and experience provide basic building blocks of any capacity for managerial success. However, those particular antecedents of adequate performance remain independent of a multidimensional capacity as

reflected in several simulation measures. The independence of these predictors is especially evident at more senior managerial levels. Since the subjects who participated in this research came from a variety of employment levels, positive (but not excessive) correlations between measures of strategic simulation performance and measures of biographic success were anticipated. The obtained correlations between measures of strategy and educational level were also anticipated. The reader should note that correlations for scores of high level strategy (e.g., Measures 9Q and 10Q) are not significantly correlated with educational level while scores of simple strategic responding (e.g., Measures 3 and 4P) are.

## MULTIPLE REGRESSION

Through the application of stepwise multiple regression procedures, we can determine the degree of the contribution of specific simulation based measurement to biographic success. For this purpose, separate regression equations were calculated for applicable simulation measures as they predict Job Level and Personal Income. In addition, stepwise regressions were performed to determine Factor Score* contributions to Job Level and Personal Income. Only significant (beyond $p = .05$) regressions will be reported in this paper.

### Primary Analysis

1. Regression of Simulation Measures on Job Level

Both Measure 33 (Number of Disaster Decisions, an indicator of relevant activity at the point of an emergency) and Measure 8 (Number of Unintegrated Respondent Decisions, a measure of rather simplistic performance) predicted Job Level. As one might expect, predictions by Measure 33 were positive; predictions by Measure 8 were negative in nature. The obtained beta weights and significance levels are presented in Table 4.

2. Regression of Simulation Measures on Personal Income

Both Measure 18 (Most Recent Response Speed, a measure of the rapidity with which a person responds to incoming information) and Measure 28P (the Number of Integrated Information Search Decisions as a Proportion of the Total Number of

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*Factor scores for all 111 participants were calculated for the 10 factors deemed useful (see above).

TABLE 4

STEPWISE REGRESSION BASED UPON SIMULATION RAW DATA

| Prediction of | | Measure | Beta Weight | p = |
|---|---|---|---|---|
| Job Level | 33 | Number of Disaster Decisions | .29 | .002 |
| | 8 | Number of Unintegrated Respondent Decisions | -.20 | .04 |
| Personnel Income | 18 | Most Recent Response Speed | .30 | .001 |
| | 28P | Information Search Decisions Integrated | .23 | .01 |

| Prediction of | | Factor | Beta Weight | p = |
|---|---|---|---|---|
| Job Level | 4 | Complex Strategy | .19 | .04 |
| Personal Income | 9 | Response Speed | .30 | .002 |
| | 7 | Information Search Activity | .20 | .03 |

Decisions) predicted Personal Income. Both predictions were positive in nature. The beta weights and significance levels are presented in Table 4.

3. Regression of Factor Scores on Job Level

Only Factor 4 (Complex Strategy) was predictive of attained job level. Apparently the simpler forms of strategic action and the speed of action represented in other Factors did not influence prior advancement among research participants. Beta weights and p values are presented in Table 4.

4. Regression of Factor Scores on Personal Income

Personal Income Levels were predicted by Factor 9 (Response Speed) and Factor 7 (Information Search Activity). Beta weights and significance levels are again presented in Table 4.

The results point toward strategic competence (especially at high levels), to the strategic application of search activity, toward appropriate response frequency and speed and toward the avoidance of simplistic responding to information as likely antecedents of managerial success.

Secondary Analysis

A second stepwise regression analysis repeated the procedure above. However, in advance of this regression procedure, scores obtained from the Shamba simulation and those obtained in the Disaster simulation were matched on the basis of earlier responses by previous simulation participants. The latter had (in random order) performed in both simulations. The obtained regression results did not differ widely from the primary

regression data presented in Table 4:

1. Regression of Matched Simulation Measures on Job Level

Only Measure 21P (Integration Across Categories as a Proportion of Number of Decisions) predicted the attained job level of respondents. Beta weights and significance levels are presented in Table 5.

2. Regression of Matched Simulation Measures on Personal Income

Personal Income was significantly predicted by Measure 18 (Most Recent Response Speed) and Measure 28P (Integrated Information Search Decisions as a Proportion of the Number of Decisions). These data are highly similar to the results obtained earlier for unmatched simulation measures. The resulting beta weights and significance levels are again found in Table 5.

3. Regression of Factor Scores from Matched Data on Job Level

Attained Job Level was predicted by Factor 4 (Complex Strategy) and Factor 11 (Recovery). Beta weights and p values are found in Table 5.

4. Regression of Factor Scores from Matched Data on Personal Income

Personal Income was predicted by Factor 9 (Response Speed) and Factor 7 (Information Search Activity). The obtained predictors again match those generated by factors derived from unmatched simulation data. The resulting beta weights and significance levels are again found in Table 5.

## TABLE 5

## STEPWISE REGRESSION BASED UPON TRANSFORMED SIMULATION DATA

| Prediction of | | Measure | Beta Weight | p = |
|---|---|---|---|---|
| Job Level | 21P | Proportion of Integrations across Categories | .29 | .002 |
| Personnel Income | 18 | Most Recent Response Speed | .30 | .001 |
| | 28P | Information Search Decisions Integrated | .23 | .01 |

| Prediction of | | Factor | Beta Weight | p = |
|---|---|---|---|---|
| Job Level | 4 | Complex Strategy | .56 | .002 |
| | 11 | Recovery | -.40 | .03 |
| Personal Income | 9 | Response Speed | .30 | .001 |
| | 7 | Information Search Activity | .23 | .01 |

## SUMMARY

It is clearly evident that a number of simulation based measures as well as some of the factor scores are predictive of managerial success. Such findings should be expected on the basis of complexity theory (Streufert and Streufert, 1978; Streufert and Swezey, 1986), especially where participants in simulations are senior managers. It should, however, be noted that the participants in this research were drawn from a population with generally lower levels of managerial experience. At those lower levels, however, the impact of education, training, and previous relevant experience, etc., upon performance and success would likely be considerably greater, in turn diminishing the impact of *simulation based measurement* upon the prediction of achieved success. Since, nonetheless, considerable (significant) predictive capacity was obtained, simulation measurement, especially where it can be based on multiple (independent) scoring of several different performance attributes, can be very useful. While the present data suggest quite adequate validity levels, much higher levels of predictive validity should be expected at more senior managerial levels, i.e., wherever the impact of training, experience, etc., is diminished in importance.

It may be useful to summarize the obtained results in more popular terminology. the following list of managerial performance characteristics which are assessed by scores obtained

via our simulations* have been shown to be significant predictors of managerial success:

1. Adequate attention to problems/emergencies (Measure 33).

2. Appropriate Information Search Activity and Information Utilization (Measures 27P, 28P and Factor 7).

3. Time Length of Planning (Measure 6Q - negative impact).

4. Delay between Information Receipt and Response (Thinking Time before Initiating Action: Measures 11, 18, 29 and Factor 9).

5. Simplistic Actions (negative impact, Measures 8, 8P).

6. Breadth of Approach to Complex Task Demands (Measure 21P).

7. Applications of Basic Strategy (Measure 4P).

8. Quality of Strategy (including higher level strategies, Measures 9, 9Q and Factor 4).

9. The Capacity to Shift from a Strategic to a Problem Oriented Approach, as Needed, and the Capacity to Return to Strategic Thinking when Emergencies are Resolved or Problems are Diminished (Measure 26 and Factor 11).

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*The Measures or Factors that are associated with each of the more popular performance descriptions will be listed in parentheses.

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